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FISHERY MARKET NEWS

AUGUST 1943

PROGRESS IN TECHNOLOGY

ISSUED BY THE
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
WASHINGTON

UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, Secretary

FISH AND WILDLIFE SERVICE
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FISHERY MARKET NEWS

A REVIEW OF CONDITIONS AND TRENDS OF THE COMMERCIAL FISHERIES

PREPARED IN THE DIVISION OF FISHERY INDUSTRIES

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FISHERY MARKET NEWS

August 1943 | Washington 25, D. C. | Vol. 5, No. 8

TECHNOLOGICAL INVESTIGATIONS - PROGRAM OF RESEARCH 1943-44

By R. W. Harrison*

The established function of the Technological Section is to aid the fishing industry in obtaining more efficient and effective utilization of the products of our fisheries. In performing this function, studies are made of the more important technological problems of the industry, and research conducted by some 50 professionally-trained chemists, bacteriologists, and engineers employed in the Service's technological laboratories at College Park, Maryland; Seattle, Washington; Ketchikan, Alaska; and Mayaguez, Puerto Rico. Much of the work is carried on in the field in conjunction with fishermen and processors; thus, a practical commercial approach is maintained.

The program of research for the current fiscal year is again concerned with wartime problems, many of which represent serious obstacles to fish production. Fulfillment of the war program, however, requires that fishery industries supply in increasing quantity essential products for military, Lend-Lease, and civilian use. So that the commercial fishing industry may be properly informed of the nature and scope of the technological work now being done by the Fish and Wildlife Service, a brief outline of the research program for 1943-44 is given below.

I. Investigations on fishing methods and fishing gear.

(a) To determine the feasibility of adapting the shrimp trawler-type vessel to the purse-seine fishing method used on the Pacific Coast, as a means of increasing the production of menhaden, mackerel, mullet, and other schooling species in South Atlantic and Gulf waters.

(b) To investigate otter-trawl fishing in southern Alaska, as a new source of fish production from this area.

(c) To determine the suitability of sisal, jute, and other fibers as substitutes for manila in meeting the cordage requirements of the fishing industry.

II. Investigations on containers for fishery products.

(a) To test the suitability of all fiber, fiber wall-metal end, and chemically-treated blackplate containers for refrigerated shipment of fresh-shucked oysters, clams and mussels, fresh-picked crab meat, shrimp meat, and lobster meat, and fresh fillets.

(b) To test the suitability of metal plates of lesser tin content in the manufacture of containers for canned fishery products.

(c) To develop packaging methods for shipping fresh fishery products refrigerated with dry ice.

III. Investigations on preservation of fishery products.

(a) Fresh fish and shellfish.

(1) To develop suitable methods for handling mussels and ocean quahogs.

(2) To improve methods for handling fresh fishery products in Puerto Rico.

(b) Frozen fish.

(1) To study the freezing of shark meat and other neglected fishery products, including various Alaskan species.

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* Chief, Technological Section.

(c) Canned fish.

(1) To develop special canned fish products for Government or domestic purchase and recommend methods and standards of pack; i.e., mussels, selected cuts of pilchard, Boston mackerel, mullet, and ground fish utilizing minor or neglected species.

(d) Salted and smoked fish.

(1) To determine acceptable methods for salting and/or smoking under-utilized or waste species.

(e) Dehydrated fish.

To determine (1) methods of manufacture, (2) most practical raw materials, (3) keeping qualities and storage requirements, and (4) best methods of utilization.

IV. Investigations in fish cookery and nutrition.

(a) To develop recipes for various fishery products, particularly new or under-utilized species, develop formulae for special canned products required by Government agencies, and conduct fish cookery demonstrations.

(b) To determine and evaluate nutritive properties other than protein value, which make fishery products desirable in the nation's wartime diet.

(c) To evaluate the effect of method of cooking or processing on nutritive properties of fishery products.

V. Investigations on plant sanitation and other health aspects.

(a) To develop sanitation standards for the guidance of fresh fish and fish processing plants.

(b) To determine standards for scoring shellfish.

(c) To determine standards for evaluating bacterial pollution.

(d) To investigate parasitic infestation in new or under-utilized species and determine practical remedial measures.

(e) To determine if certain Puerto Rican species and other unutilized fishery products have toxic properties.

VI. Investigations on fishery byproducts and miscellaneous aquatic products.

(a) Vitamin oils.

(1) To investigate fishery materials as potential sources of vitamin A.

(2) To collaborate with the State of Washington in a study of soupfin shark and dogfish livers.

(3) To investigate factors influencing the stability of vitamin A in fish livers and fish liver oils and methods of evaluating stability.

(b) Seaweeds.

(1) To develop specifications and tests for defining bacteriological agar.

(2) To improve methods of agar extraction.

(3) To study seasonal variation of agar content of Gelidium.

(4) To study decomposition of Gelidium and deterioration in storage.

(5) To determine the yield and properties of extracts from seaweeds other than Gelidium, as potential sources of agar or useful seaweed gums.

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JUDGING THE QUALITY AND FRESHNESS OF FISH BY ORGANOLEPTIC METHODS

By Maurice E. Stansby*

Fish are among the most perishable of all foodstuffs and accordingly in the sale and distribution of this food it is important to have testing methods for distinguishing with reasonable accuracy various degrees of freshness. Such tests are of value in the sale of fish by the fishermen, in various intermediate transactions between producers, wholesalers, and retailers, and in ultimate purchase of the fish by the homemaker.

Quality in fish--Before discussing the various methods for determining freshness of fish it will be well to establish just what properties constitute quality in fish. Although such criteria as clear eyes, bright red gills, etc., are often used as indications of the freshness of fish, actually the ultimate consumer is primarily interested in only the three properties, keeping quality after purchase, appearance and odor during preparation, and palatability of the cooked fish.

Keeping Quality After Purchase--If fish is purchased for immediate consumption the keeping quality need not be given as much consideration as when it must be kept for a day or two before cooking. Fish are frequently purchased in the morning and placed in the household refrigerator until evening, or the following day. Prior to sale, the fish was kept in crushed ice at a temperature not much above 32° F. and when removed from the ice for delivery, the temperature immediately rises, oftentimes considerably, since no attempt is made to refrigerate it during delivery.

The spoilage rate of fish is dependent upon a number of factors. The rate of spoilage increases greatly with increasing temperatures, so the rate of decomposition of fish stored at the temperature of the average household refrigerator is about four times as great as that of fish kept well-iced. For example, a fish which would remain in good condition for 36 additional hours if kept in ice at the retail store would keep only about 9 hours in a refrigerator in the home. The keeping quality of the fish after sale to the consumer is of considerable importance, since it is not so much the condition of the fish when purchased, but the condition of the fish several hours later which is of most importance. Therefore, buyers at the fishing wharf will want to be certain that the fish which they buy from the fishermen not only are of high quality at the time of purchase, but also that they will keep in good condition until they reach the ultimate consumer.

Appearance and Odor During Preparation--A fish of high quality must have an appetizing appearance, especially during preparation. Of even more importance is the presence or absence of decomposition odors during preparation and cooking of the fish. Many fish give off a stale or putrid odor during cooking, yet have no bad odor or flavor when eaten. The bad odors had been driven off during cooking and anyone present during preparation may not relish the fish when served. Many people are under the impression that this condition is always encountered whereas only fish of inferior quality give off bad odors during cooking.

Factors Affecting Palatability--Palatability is determined by numerous factors, the more important of which are:

1. Normal flavors and odors.
2. Satisfactory texture.
3. Good appearance of cooked fish.

Each species of fish contains various aromatic substances which give the flesh its characteristic flavor and odor. Moreover, fish contain numerous mineral substances which not only contribute to the flavor, but add considerably to its nutritive value. When fish are not handled properly, a portion of these substances may be lost, and such fish are not of high quality. Anyone can distinguish fish having a stale odor, but what is not so generally recognized is that an aftertaste left in the mouth after eating is due to poor quality fish. An aftertaste usually is due to rancid oil, and is not present when high quality fish have been eaten.

The texture of flesh should be tender, firm, and moist. In many species of fish, the flesh falls apart in flakes when cooked, but this is not a characteristic common to all

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fish. Various abnormal textures are sometimes observed such as stringy, rubbery, jelly like, or tough. While these characteristics may be due to improper methods of cooking, they also may be due to improper handling.

ORGANOLEPTIC TESTS

Organoleptic tests or determination of quality through use of the senses of sight, touch, odor, and taste are the means most widely used to determine freshness of fish. Organoleptic tests can be divided into two categories; namely, the fundamental, and the accessory tests. The fundamental tests are those which measure factors directly responsible for the quality of the fish such as odor, flavor, appearance, and texture.

The accessory tests involve observations of characteristics which normally occur simultaneously with changes in quality but which are not directly involved. Such characteristics include the appearance of the eyes, gills, and viscera; and the amount and appearance of the slime, etc. These characteristics are not entirely reliable indices, but are convenient to determine. Thus, when purchasing fish in the round, the condition of the eyes and gills may be noted in order to predict the probable quality which cannot be determined more definitely until the fish has been dressed, or cooked and tasted.

Chemical and bacteriological tests have also been promulgated which can be used when time permits. These tests are almost invariably of the accessory type, since they usually measure substances which form simultaneously with fish spoilage but which are at most only partially responsible for spoilage. Such tests have the advantage of determining the condition independent of the personal judgment of the observer, and which can be reproduced with considerable accuracy. In technological investigations they are often invaluable. Their limitations are that they must always be carefully standardized against the fundamental organoleptic tests, and usually considerable time is needed before the results are obtained.

Whole Fish--Observations which can be made on whole fish are unfortunately limited to the accessory tests. Even tests for odor must be so classified since it is impossible to distinguish the odor of the flesh from that of the gills, slime, viscera, or other extraneous sources.

One of the most important observations which can be made upon whole fish is the presence and degree of rigor mortis. A fish is soft and flabby just after being removed from the water. Indentations made with the finger tips on the surface tend to remain. Soon after catching, the muscle proteins coagulate, and this causes a shortening of the muscle fibers and the development of the characteristic stiffness of rigor mortis. In extreme cases, the fish is stiffened into an arc and can hardly be straightened.

Fish which are in rigor mortis are almost certainly of excellent quality. Usually some decomposition is present in fish not in rigor mortis and other suitable tests will show the extent.

Anderson (1907)* lists conditions under which rigor mortis is late in appearing and lasts longer; consequently, the fish keep better:

1. Fish in season.
2. Fish in healthy and vigorous condition.
3. Fish which are killed at once on capture.
4. Fish which are not only killed but pitted at the same time; that is, have the brain and spinal cord destroyed.
5. Fish gutted immediately upon capture.
6. Fish handled as little as possible after capture.
7. Fish kept at low temperature as when iced or kept in cold storage.

All of these conditions not only influence the length of rigor mortis, but are also factors in obtaining fish of high quality. The presence of full rigor mortis is not only an indication that the fish are absolutely fresh, but also that good handling methods have been used. Furthermore, rigor mortis is accompanied by an increase in the acidity of the muscular tissue and a setting of the flesh to a gel-like consistency, both factors which discourage bacterial invasion.

The odor of whole fish is another important index, but one which must be interpreted with care in order to avoid erroneous conclusions. Fresh fish usually have a characteristic

* Anderson, A. G., 1907. On the decomposition of fish. Fish. Res. Bd. Scotland Rept. 26, pt. 3: 13-39.

fishy odor, somewhat similar to seaweed, and a fish which has just been taken from the water ordinarily has no other odor. Fish which are not eviscerated frequently give off odors suggestive of decomposition long before any spoilage of the flesh has taken place. This is usually caused by a rapid decomposition of the substances upon which the fish have been feeding. A pronounced hydrogen sulfide odor from this cause is sometimes present in fish which are less than six hours out of the water.

The gills and slime of fish usually give off more pronounced decomposition odors than the flesh, and this fact is useful in predicting incipient decomposition. A fish in which the gills and slime have a perfectly fresh odor is apt to be in good condition while if the odor is stale, the fish itself may still be in good condition but will not remain so for long.

The degree of odor of fish is markedly effected by temperature. Thus, fish which are near the temperature of melting ice may have an imperceptible odor which might be increased to a relatively stale one, if the temperature of the fish were raised to ordinary room temperature.

The odor of fish kept in finely-packed ice ordinarily progresses from fishy through one of sweetness, to staleness, and finally becomes putrid. The latter is caused by such substances as hydrogen sulfide, indole, etc.

The eyes of fresh fish have a bright transparent appearance which becomes cloudy, and often assumes a pink color when fish are stale. When fish are fresh, the eyes often protrude, and with increasing staleness, they tend to sink. Gills of fresh fish are commonly bright red, and the color gradually fades to a light pink, then to a yellow, and finally, to a brown or sometimes a green shade. These changes in the eyes and gills do not always occur simultaneously with the spoilage of the flesh so they are not entirely reliable and the absence of such changes is not proof of the freshness of the fish.

Immediately after a fish is caught, it often exhibits a striking pearlescent appearance, if held so that the light strikes the fish at the correct angle. This "rainbow" effect somewhat resembles the appearance of pearls or some sea shells. The pearlescent appearance wears away relatively rapidly, so that any fish showing this characteristic is almost certainly in excellent condition. The absence of the pearlescent colors is no evidence of decomposition, since with some species, the beforementioned appearance is less striking, or it may be completely lacking.

Each species of fish has certain characteristic markings and colors. As the fish becomes stale, these patterns and colors fade and become less pronounced. Also, during the spawning season, the appearance may become somewhat abnormal with unusual colors often being observed.

The slime on fresh fish is transparent, almost water white, and usually not enough is present to be conspicuous except by the slimy feeling. As spoilage progresses, the slime increases in amount, becomes turbid and finally thick and often of a yellow color. Presence of such slime is good evidence that the fish is not fresh but its absence is meaningless, since it can easily be removed.

Dressed Fish--During the dressing operation, a number of observations can be made which are not possible with round fish. If the fish has not been eviscerated, the condition of the viscera may show some evidence of decomposition. Each organ, such as the heart or liver, is intact and easily recognizable. When extensive decomposition has occurred, the viscera may be an almost homogeneous mass in which one organ cannot be distinguished from another.

If the odor of the flesh is observed when the fish is first cut, and then again a short time later, the first odor is sometimes much stronger than the second. The first odor may represent an accumulation of gases, either from the flesh or from the contents of the viscera. The skin of fish is almost impervious to gases, so that a very small evolution in the body cavity over a period of time may produce an odor which will lead to a wrong conclusion unless the odor is again noted a few minutes later.

The flesh between the viscera and the backbone of fresh fish is firm and sound. If the fish is handled in the round, the enzymes from the digestive system start to decompose

the flesh in this region. Shortly after death, the flesh adjacent to the bone begins to soften and eventually may become almost entirely broken down so that a small amount of handling, such as occurs during filleting, causes the bone to separate from the flesh completely. These changes are sometimes accompanied by the formation of a peculiar yellowish gloss on the flesh near the backbone. This gloss sometimes described as an "apple jelly appearance" is suggestive of extensive decomposition.

Frequently, fish which have been held for some time show a reddening of the flesh near the backbone, and in the more advanced stages of decomposition, the color changes to a brown, as the hemoglobin is changed to methemoglobin.

The texture of fresh fish is firm and very little liquid can be expressed even when very heavy pressure is applied. As decomposition proceeds, the texture softens and sometimes fluid is spontaneously liberated. At the same time, the appearance of the flesh changes from a transluscent sheen to a dull luster. The color may also fade if the original shade is other than white, and, in the latter event, it may become somewhat yellow.

Cooked Fish--Since odors are more intense at high temperatures, it is not surprising that more intense odors are usually observed during the cooking of fish. Cooked fish, if fresh, has a pleasing flavor, characteristic for each species, and no aftertaste after eating. Fish of lower quality may have a variety of off-flavors. In some cases, the fish may lack some of the characteristic flavors without evidence of decomposition, and in this case, it is described as flat or tasteless. When only a small amount of decomposition is present, no difference in flavor may be noted, except possibly that there is a strong fishy or a slight "off" flavor. When more extensive decomposition has taken place, the "off" flavor may be described as acrid, bitter, stale, or even putrid. With oily fish, rancidity may lead to a persisting aftertaste, which, while perhaps not entirely disagreeable, is at least annoying.

Abnormal textures are also frequently noted in cooked fish. In some cases, the fish may be very soft, crumbling into small pieces when cut with a fork. In other instances, it may be tough, rubbery, or stringy.

Methods of Making Organoleptic Tests--In commercial marketing of fish, producers and wholesalers gain considerable experience over a period of time in judging the quality of fish by organoleptic means. The homemaker who only occasionally buys fish may have difficulty in accurately appraising quality, but by making the organoleptic tests outlined in the preceding sections anyone should soon be able to distinguish between the various stages of freshness with little or no difficulty.

In some types of examination as in the case of food inspection or in laboratory testing in connection with development of new products, or new methods of handling fish, it is sometimes necessary to be able to distinguish minute differences in quality. In such cases, it is often helpful to utilize observations of a large number of persons, and when this is done it is important that each observer make his examination independently and without knowledge of the findings of others. Some persons are unable to distinguish fine differences in odors or flavors, and if they attempt to judge the condition of fish, a rather erroneous appraisal is obtained. Under these circumstances, observers should be selected who have demonstrated their ability to obtain consistent results. Then, if an average is made of the observations of several persons, a very accurate estimate of the condition of the fish is obtained.

Estimation of Keeping Quality by Organoleptic Tests--Appraisal of keeping quality of fish by organoleptic tests is much more difficult than the mere estimation of the quality at the time of examination. Future keeping quality of fish depends not only upon its present condition, but also upon past and future handling conditions. Although some idea of the handling conditions prior to examination may be obtained through careful interpretation of the organoleptic data, usually no certain prediction as to future storage conditions of the fish can be made except in the case of the ultimate consumer who will have possession of the fish continuously until it is eaten.

Fish which are already partially stale will certainly not keep in edible condition for a much longer time. It is ordinarily the fish which still seem to be in relatively good condition about which knowledge of future keeping quality is desired. Such fish may

have been freshly caught, or they may have been kept well-iced for a considerable time. In the former case, assuming good future handling conditions will be used, the fish would be expected to keep for some time, while the keeping quality of the latter fish would be strictly limited. Accordingly, in predicting future keeping quality any indications that the fish had been stored for a considerable period are especially to be noted. For example, fish which have been iced for long periods often exhibit faded surface colors due to leaching. Another indication is a peculiar sweet odor which develops in fish held iced for extensive periods. This sweet odor is not considered especially undesirable, but since it is usually not present in strictly fresh fish it may be taken as a warning of imminent spoilage.

Any indication that the fish have been roughly handled, such as loose scales, fork holes, bruises, or general softness of the fish, should be considered evidence of poor past handling conditions and probably poor future keeping quality. Fish that have been bruised are especially susceptible to autolytic changes which may lead eventually to sudden bacterial putrefaction. Finally, fish taken near the end of the spawning season keep less well than those taken at other times.

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DRY ICE REFRIGERATION OF FRESH FISH FILLETS

By E. F. Kapalka and R. H. Flowers*

During the past several years, various attempts have been made to use solid carbon dioxide (dry ice) as a refrigerant in packing fresh fish for shipment. Owing to the difficulty of controlling the temperature and preventing freezing, the method has not been generally used for unfrozen fish. However, recent restrictions placed on the use of tinplate in the manufacture of fillet boxes for shipping fish fillets packed in ice has created a need for further study of this method of refrigeration.

In the course of investigations by the Fish and Wildlife Service on non-metallic containers for packaging fish, experiments were conducted to test fibre fillet boxes refrigerated with dry ice. The fillet boxes were packed in corrugated fibre containers and were insulated from the dry ice by recently invented pads designed for this purpose. The studies were made at the Service's Technological Laboratory, College Park, Maryland, in cooperation with the Merkle Corporation and the Container Corporation of America, both of Philadelphia, Pennsylvania. The first mentioned firm furnished the Merkle insulating pads and the second furnished the fibre fillet and corrugated boxes.

Description of Package--A shipping unit holding two 20-pound packages of fillets was chosen as being the most satisfactory from the standpoint of trade practice and ease in handling. Initial experiments were made to determine the proper sizes of the shipping container and the fillet boxes, the most effective distribution of the dry ice, and the proper amount of insulation to prevent the fillets from freezing.

The fillet boxes were of the telescopic type, and constructed of lightly-waxed fibreboard 1/16 inch in thickness. The inside dimensions of these boxes were 21¼ by 10½ by 2¾ inches. A typical 20-pound tin fillet box measures approximately 15 by 10⅛ by 4 inches. The longer and more shallow fibre fillet box was selected in order to obtain more rapid cooling of the fillets and more uniform temperatures. The size was such that 20 pounds of fresh haddock or cod fillets completely filled the box.

A corrugated container or "ice box" was used for each shipping unit to hold the dry ice and to prevent the movement of the contents within the shipping container. The inside measurements of the "ice box" were 21-9/16 by 10-5/8 by 4 inches, and the board was 3/16 inch thick. The "ice box" was prepared in advance, so that it could be placed as a unit between the two fillet boxes in the shipping container. Two slabs of dry ice, wrapped in ordinary single thickness wrapping paper, or in a few thicknesses of newspaper, were placed inside the "ice box" horizontally sandwiched between two Merkle insulating pads. By placing the dry ice between the packages of fish fillets a more symmetrical arrangement was possible. Satisfactory refrigeration would then be maintained if the packages were accidentally inverted.

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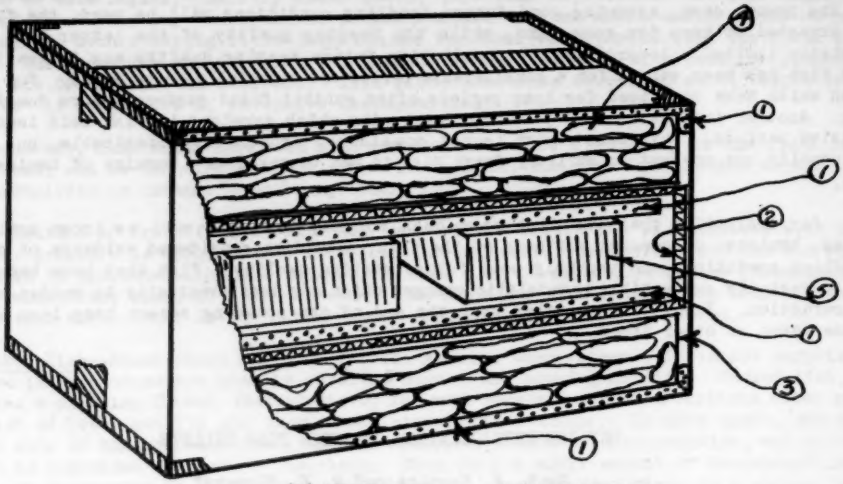

(1) MERKLE PAD (3) FILLET BOX

(2) "ICE BOX" (4) HADDOCK FILLETS

(5) DRY ICE

In the early tests, a flexible 14-ply Merkle insulation pad was used below the dry ice, and a 6-ply flexible pad over it when the "ice box" was prepared. Reasonably good control of the refrigerating action of the dry ice was secured. In later experiments, the insulation under the dry ice was changed to a rigid 6-ply Merkle pad, 1¼ inches thick, and that over the dry ice to a flexible 2-ply Merkle pad. This insulation combination was used in the "ice box" for all subsequent tests.

The recommended shipping container was constructed of A and B fluted, corrugated paperboard, 5/16 inch in thickness. The inside dimensions, 22-3/8 by 11½ by 12 inches, were such that there was a small space between the walls and the fillet boxes, which was filled by carbon dioxide gas from the dry ice, which in turn acted as insulation. The container was so cut that the top and bottom side flaps fitted snugly end to end, giving the maximum structural strength and best conditions for thorough sealing.

Method of Packing--In packing the shipping container, a 4-ply Merkle pad, 25-3/8 by 11-3/8 inches, was placed in the bottom. The length of the pad was sufficient to give a 1½ inch overlap turned up at each end, making it possible to reduce thermal leakage by covering the seams and cracks in the bottom of the shipping container with an insulating material.

A fillet box holding 20 pounds of fresh fish fillets, precooled to 38° to 40° F. for moderate outside temperatures or lower for very warm outside temperatures, was set on the insulating pad which overlapped each end of the box. The "ice box", which was previously assembled with a suitable amount of dry ice, was placed above the fillet box, followed by the second fillet box. A 4-ply pad similar to that used for the bottom of the container was placed over the top fillet box, and the overlapping ends were bent down around the ends of the box. The shipping container was then thoroughly sealed with heavy three-inch gummed tape.

Experimental Results--A package containing 40 pounds of fresh cod fillets was held in a room in which the temperature was maintained at approximately 70°F. continuously during the test. The temperature was obtained on a recording resistance thermometer by means of thermocouples placed in various parts of the package. The package was not disturbed at any time during the test.

The following temperatures were obtained in the fish when 23½ pounds of dry ice were placed in the "ice box" at the start of the test:

Time in Hours	Degrees Fahrenheit
At start	37 to 41
24	30 to 38
48	29 to 36½
67	30 to 37½

Four pounds of dry ice remained at the end of the test. One fish fillet had a slight surface freeze or "nip" on the side closest to the dry ice. A slight surface freezing or "nipping" on the layer of fillets closest to the dry ice was considered desirable, since it was indicative of near freezing temperatures. The appearance and odor of the fillets were unchanged.

In general, it was found that when packages containing small amounts of the dry ice were resealed and held overnight in a refrigerated cold room at 40° to 45° F. without additional dry ice, the temperature of the fish rapidly dropped to 30° to 32° F. These cold temperatures were maintained as long as the dry ice remained. These findings suggest that packages containing small amounts of dry ice may be stored in cold rooms on receipt of shipment without additional icing.

Packaging Periods--Experiments were performed to determine the amount of dry ice that was necessary for different periods of refrigeration at outside temperatures of approximately 70° F. The amounts of dry ice in the "ice box" were varied, and the temperature of the fillets recorded. Each test was continued until the temperature in the fillets began to rise rapidly.

The data on quantity of dry ice used for different periods of satisfactory refrigeration are presented in Table 1.

Table I - Pounds of Dry Ice Used in a Shipping Package Containing Two 20-pound Fibreboard Boxes of High Quality Unfrozen Cod or Haddock Fillets for Varying Periods and Outside Temperatures

Period of Packing	Outside Temperature Range, Degrees Fahrenheit		
	35-55	55-75	75-90
Hours	Pounds	Pounds	Pounds
24	7-9	12-13	16-22
36	11-14	17-18	24-30
48	15-17	20-21	28-34
60	18-19	22-23	*
72	19-22	25-26	*
96	23-27	30-31	*

*Tests under these conditions were unsatisfactory.

Experiments were also performed to determine the effect of outside temperature on the length of satisfactory refrigeration. It was found that when a shipping package contained 22 to 24 pounds of dry ice for each 40 pounds of fillets, satisfactory refrigeration was obtained for 36, 60, and 96 hours, respectively, for hot, moderate, and cold outside temperatures.

High temperatures outside the package had a considerable effect on those within the container. When the temperature was as high as that commonly encountered during hot weather, the temperature of some of the fish farthest from the dry ice rose beyond desirable limits, although a large excess of dry ice was used. In a typical 48-hour experiment, during which the outside temperature varied from 75° to 90° F. the following temperatures were recorded in the fish fillets:

Time in Hours	Degrees Fahrenheit
At start	44½ to 48
24	35 to 42
48	33 to 52½

After 48 hours the temperature rose rapidly. The same effects were obtained in all the experiments at high outside temperatures. It is to be noted that the higher temperature was found in fillets in the ends of the boxes which are farthest from the dry ice; whereas, the colder temperature was found in the greater proportion of the fish.

Discussion--When the shipping package containing 40 pounds of fillets was kept continuously at outside temperatures of 75° to 90° F. for more than 48 hours, unsatisfactory temperatures, above 50° F., were obtained in parts of the containers farthest away from the dry ice. Therefore, at high outside temperatures, packaging is limited to periods of 48 hours or less. If the package is placed in a cooled atmosphere, as in a refrigerated car or truck, the period can be extended considerably beyond the 48-hour period. Successful packaging tests for periods up to 90 hours duration have been made when the outside temperature varied from 65° to 75° F.

It appears that 70° to 75° F. is a critical outside temperature range for this package, below which the cooling effects of the dry ice predominate over the heating effects of the environment. Above this critical range the temperature in the package farthest from the dry ice becomes too high after 48 hours, although a sufficient amount, 28 to 34 pounds, of dry ice was used. A greater quantity of dry ice did not reduce the temperature.

The gross weight of the package which held 24 pounds of dry ice and 40 pounds of fillets was 78 pounds. The outside dimensions were approximately 23 by 12 by 12½ inches.

It is important that the dimensions given for the various parts of the container assembly be closely followed. Any important changes in these measurements may cause variations in the thermal effects inside the container or may upset the insulation balance so that poor performance may result even under cool outside temperatures. Thorough sealing of the container is necessary so that a carbon dioxide envelope is maintained around the fillet boxes.

CONCLUSIONS

1. A method of packaging fresh cod and haddock fillets for shipment with dry ice is described, which gave a satisfactory performance under laboratory conditions.

2. Packages containing two 20-pound fibreboard boxes of fresh cod or haddock fillets were held satisfactorily for upwards of 48 hours with 28 to 34 pounds of dry ice, under outside temperatures of 75° to 90° F.

3. The temperature range of 70° to 75° F. outside the package is critical, below which cooling effects of the dry ice are predominant over the heating effects of the environment. When the package containing dry ice and fish fillets is exposed to the outside temperature range of 75° to 90° F. the period of satisfactory packaging is limited to 48 hours regardless of the amount of dry ice used.

The results of this investigation indicate that dry ice (solid carbon dioxide) can be used to refrigerate fresh fish fillets packed in corrugated paper containers for shipment. Under certain circumstances exposure of fish to carbon dioxide has been found to improve the keeping quality, and longer periods of packing may be possible with dry ice than with wet ice. A package containing dry ice and fresh fish fillets can be made compact, so that it can be easily shipped together with other materials in railway express cars. Packages containing dry ice are dry, and there is no danger of water damage to other goods, as would occur when water ice is the refrigerant.

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KEEPING QUALITY OF EAST COAST CRAB MEAT IN FIBRE CONTAINERS AND IN TIN CANS

By S. R. Pottinger*

With the increased usage of heavily-waxed fibre containers brought about by restrictions placed on the use of metal, the question has arisen regarding the keeping quality of fresh cooked East Coast crab meat packed in these containers. During a survey of crab meat dealers in several large cities, the complaint was heard that the meat does not remain in a fresh condition for as long a period in heavily-waxed fibre containers as in tin cans, especially when shipped in very warm weather. On the other hand, a number of dealers reported the crab meat to keep equally well in either type of container.

In view of this disagreement of opinion among the handlers of fresh cooked crab meat, and as a phase of the general container investigation, preliminary tests were conducted to

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determine whether the storage life of properly refrigerated fresh-cooked East Coast crab meat is affected by packing in fibre containers. In addition to the heavily-waxed fibre crab meat containers, the effect of other types of containers was also studied. One-pound size containers were used in all tests.

Laboratory Tests--Fresh-cooked crab meat was obtained directly from the picking table of a nearby crab meat packing house and placed in the following containers:

1. Heavily-waxed fibre crab meat cans with holes in bottom;
2. Regular tin crab meat cans;
3. Lightly-waxed fibre crab meat cans without holes in bottom;
4. Heavily-waxed fibre crab meat cans without holes in bottom;
5. Hermetically-sealed tin cans.

The cans were placed immediately in crushed ice and held until the meat was no longer considered to be in a fresh condition, organoleptically. Additional containers filled with crab meat were included for opening at intervals to determine the approximate condition of the meat and to indicate the time at which the cans under test should be examined.

At the end of 15 days of storage, the meat was still in a fresh condition in all cans, with the exception of those hermetically-sealed, which were not examined. After 17 days, the meat in the lightly-waxed fibre cans without holes was found to be slightly sour. The fibreboard was quite watersoaked and soft, and the meat was somewhat soggy. The meat in the remaining cans was still fresh.

At the end of 19 days, the meat in the heavily-waxed fibre containers and in the tin cans, both with holes in the bottom, was considered as being no longer in a fresh condition. At the same time, the meat in the hermetically-sealed tin cans had a fairly fresh odor in the upper part of the cans but was putrid in the lower part. A small quantity of free liquid was present in the bottom of these cans, and the meat was soggy. After 20 days of storage the meat in the heavily-waxed fibre cans without holes in the bottom was slightly sour and was somewhat soggy in texture.

A second series of tests was run, similar to the before-mentioned, but including, in addition, lightly-waxed fibre cans with holes in the bottom. Unfortunately, the crab meat used in this series was afterwards found to be grossly contaminated, and therefore of questionable quality for use in tests of this nature. The test was continued, however, until the meat showed signs of spoilage, organoleptically.

There was no indication of spoilage occurring until the 12th day of storage, at which time the meat in all of the cans had a slightly sour odor and was rather soft. No difference was noted in the odor of the meat in the top and bottom parts of the hermetically-sealed cans. A small quantity of free liquid was present in the bottom of these cans. Bacterial counts made on the crab meat in the sealed cans showed a count of 154,000 per gram for the meat in the top part of the can and 134,000 for the meat in the lower part.

Shipping Test--In order to obtain information regarding the effect on the keeping quality of shipping crab meat in fibre and in tin containers, a shipment was made from a packing house in Biloxi, Mississippi, to the laboratory at College Park, Maryland. The crab meat was obtained directly from the picking table and packed in five heavily-waxed fibre crab meat containers and five tin crab meat cans containing one pound each, under the supervision of a Service technologist, for shipment. The meat was in transit two days.

Upon arrival at the laboratory, the cans were found to be reasonably well iced. The average temperature of the meat at the center of the fibre cans was 37° F. and in the tin cans, 36° F.; near the walls of the cans the average temperature was 38° F. and 39° F., respectively. The meat was in good condition in all of the cans. They were immediately packed in crushed ice in the laboratory and held for further examination.

After being held in storage for ten days, slight spoilage of the meat was apparent in one fibre and one metal can. The meat in the remainder of the cans was still fresh. After 14 days in the laboratory, or 16 days from the time of packing, the meat in the remaining fibre and tin cans had become slightly sour. There was no apparent difference in the relative state of freshness of the crab meat in the two types of cans.

Discussion and Summary--Although these tests were conducted primarily to determine the relative keeping quality of fresh-cooked East Coast crab meat packed in heavily-waxed fibre crab meat containers and in tin crab meat cans, some indication as to the suitability of other types of containers was also obtained. The results of shipping and storage tests showed no appreciable difference in the keeping quality of crab meat packed in heavily-waxed fibre and tin crab meat cans with holes in the bottom, and in heavily-waxed fibre cans without holes in the bottom.

While it was found, as a result of one test, that the meat in the upper part of the hermetically-sealed cans remained fresh longer than that in the regular type of crab meat cans, the meat in the lower part was, at the same time, in an advanced state of spoilage. Free liquid found in the bottom part of these cans may be a factor in causing this spoilage, as a number of crab meat packers have stated that proper drainage of the meat in the cans is essential in order to prevent rapid souring.

The meat spoiled somewhat more rapidly in lightly-waxed fibre containers than in the other types. Inasmuch as these containers soften rapidly when packed in ice, it is quite doubtful whether they will be used to any great extent for packaging crab meat for distant shipments. Lightly-waxed fibre cans will at best most likely be limited for use as "carry-out" packages, and hence will not be involved in lengthy storage of the meat.

Due presumably to poor quality crab meat which was used in one series of tests, results were obtained which were somewhat different from those obtained in a previous test. However, the results of the tests, in general, indicate that East Coast crab meat remains fresh equally as long in heavily-waxed fibre crab meat containers as in tin crab meat cans when kept thoroughly covered with ice.

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THE NUTRITIVE VALUE OF THE PROTEIN OF SOME DEHYDRATED FISHERY PRODUCTS

By William A. Martinek and Barbara Jacobs*

Renewed interest has been shown in dehydrated foods since the war began because their low weight and bulk in proportion to food value facilitates shipping overseas and permits more efficient storage. Considerable laboratory work, including pilot plant studies, has been carried out on dehydrating fishery products at the Fishery Technological Laboratories at College Park, Maryland, and Seattle, Washington. It was deemed desirable to test samples of dehydrated fishery products to determine particularly the nutritive value of the protein.

Recently Poling and co-workers (1943) investigated the effect of dehydration, canning, roasting, and frying upon the nutritive value of beef and pork muscle proteins. In feeding experiments with rats, the differences noted were so small that they concluded the proteins would have to undergo even more drastic treatment to show a loss in nutritive value.

Dehydrated fish samples were prepared at the College Park Laboratory by Messrs. C. F. Lee and Leo Young, technologists, from fresh fish bought in local markets. The species chosen for study were cod (Gadus callarias), whiting (Merluccius bilinearis), mullet (Mugil species), and carp (Cyprinus carpio). The cod and whiting are representative of fish with a low fat content while the carp and mullet are typical of those with a comparatively high fat content.

Preparation of samples--The cod and mullet were cleaned and filleted. The carp and whiting, after cleaning, were not filleted but the large backbone was cut out. The increase in mineral content of whiting and carp is attributed to the numerous bones left in the split fish. (See Table 1) These bones do not interfere with the edibility of the product, and labor costs for preparing the fish are decreased.

The coarsely chopped flesh was cooked in a horizontal retort. The cod and mullet fillets required about 1 hour at 232° F. for thorough cooking. More time and a higher temperature, namely, 1½ hours at 240° F., were necessary to thoroughly soften the bones remaining in the

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Table I - Analyses of Dehydrated Fish

Source of Protein	Percent By Weight			
	Moisture	Protein (N6.25)	Ether Extract	Mineral Matter
Cod	6.6	87.6	0.5	6.8
Mullet	6.1	68.8	16.8	8.2
Whiting	4.8	78.8	6.4	11.4
Carp	3.2	68.3	15.9	13.1
Cod (acetone extracted)	6.1	93.3	0.1	2.7

whiting and carp. The cooked flesh was then ground finely and spread on wire trays. These were stacked in a tray drier through which heated air was forced. With the drier fully loaded, complete drying was obtained in about 3½ hours. The maximum temperature of the air entering the drier was 165° F.

The dehydrated fish was ground in a Wiley mill and stored in sealed Mason jars in a refrigerator. The finished product varied from light cream colored particles for cod to dark buff colored granules for carp and mullet. The high fat content of carp and mullet made these particles feel greasy to the touch.

The acetone extracted protein of fresh cod was included in this study for comparison. This product is a dry powder prepared from fresh cod by the process of acetone extraction described by Lanham and Lemon (1938). These investigators also found that the nutritive value of extracted cod protein was equal to that of fresh cod.

Feeding experiments--Young albino rats were selected at an initial weight of 49 to 55 grams. They were divided into five groups of ten rats each and fed the protein test diets and water ad libitum. Each animal was housed in an individual wire cage over wire screens. Live weight and food consumption were recorded weekly for a period of ten weeks.

The dehydrated fish was incorporated to the extent of 9 percent protein by weight into a basal diet since it was shown by Lanham and Lemon (1938) that protein at the 9 percent level was the limiting factor for growth of young rats.

The basal diet was composed of: dehydrated fish to furnish 9 percent protein; U.S.P. salt mixture No. 2, 4: powdered liver extract, 0.5; dried brewer yeast, 2; wheat germ, 1; and cod liver oil, 2 parts by weight. Since the fat content of the fish samples varied so widely, the diets were made isocaloric by varying the lard content from 6 to 8 parts and cornstarch was added to make a total of 100 parts by weight.

Table II - Data on Gain in Weight, Protein Intake, and Grams Gain in Weight Per Gram of Protein Intake for a 10-week Period

Dehydrated Fish	Number of Rats	Average Gain in Weight	Standard Error	Average Protein Intake	Grams Gain in Weight Per Gram of Protein Ingested	Standard Error
		Grams	Grams	Grams	Grams	Grams
Cod	10	166	9.8	66.6	2.55	.29
Mullet	10	141	7.5	64.0	2.20	.06
Whiting	10	135	5.4	60.9	2.21	.07
Carp	10	147	10.6	64.8	2.25	.08
Cod (acetone extracted)	10	138	7.4	59.5	2.31	.10

Analyses of the finished diets showed that several of the ingredients contained nitrogen so the average protein content was 10.2 percent by weight. This value was used in all calculations to determine protein intakes and nutritive value.

The rats fed dehydrated cod made the largest gain in weight and had a correspondingly large food intake. Statistical analysis showed their gain in weight to be significantly higher than that of the groups fed acetone extracted cod and dehydrated whiting, which also had the lowest protein intake. Since there were no significant differences in the grams gain in weight per gram of protein ingested for any of the groups, the difference in the gains in weight is probably not due to any apparent loss in nutritive value of the fish protein.

Apparent digestibility coefficients obtained by measuring the percent of protein loss by excretion during the eighth week were not significantly different. All fishery products were about 87 percent digestible.

Table III - Data on the Apparent Digestibility of Dehydrated Fishery Products

Dehydrated Fish	Number of Rats	Apparent Digestibility	Standard Error
		Percent	Percent
Cod	7	89	4.90
Whiting	5	87	.81
Mullet	7	84	.80
Carp	7	87	.43
Cod (acetone extracted)	8	90	.60

Summary--The proteins of dehydrated cod, mullet, whiting, and carp were compared at a level of nine percent by weight in the basal diet.

The process of dehydration as described in this study did not adversely affect the nutritive value or the apparent digestibility of the fish proteins.

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STUDIES ON SUBSTITUTE CONTAINERS FOR CANNED FISHERY PRODUCTS

By Norman D. Jarvis and Lynn G. McKee*

Early in 1940, when war developments first made it evident that much of the tin supply might be cut off, the can-making and steel industries, the Paint and Varnish Institute, and the National Canners Association established a coordinated research program on the development of possible substitutes for the standard tin container. Studies of the Quartermasters Research Laboratory had indicated that wartime conditions of transportation and storage would call for changes in container specifications. Much data had been gathered on the effect of fruits, vegetables, milk and meat on different tinplates and enamels. Little information, however, had been collected on fishery products.

The canning industry needed and requested data on what fishery products did to tinplate substitutes already judged as most practicable for commercial use with other foods. The Fish and Wildlife Service was selected as the agency best equipped to make this investigation.

So far as was known, metal containers and glass containers were the only two types of containers available in commerce which were suitable for canned fish products. The latter would require a rubber seal, a material equally as critical as tin. Plastics could not be considered because even if technically suitable, the critical materials required in their manufacture and the idea of abandoning the vast can-making and glass-making facilities of the nation in lieu of a development which would require years to check thoroughly would be highly impractical. Besides, the use of glass would place additional burden on the already over-burdened glass container industry and would require installation of new cannery lines for a distinctly seasonal operation. Thus, when the Service's program was set up in 1942, it was felt that it could best contribute to the development of wartime containers by making experimental packs using substitute tinplates and enamels already developed and being produced in adequate quantity. Accordingly, the substitute containers were obtained through the cooperation of the can manufacturing industry. After consultation with research laboratories

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in the canning and can-making industries, the technologists of the Service decided to make packs in cans of .5 acid bath, melted fused electrolytic plate; .5 alkaline bath melted fused electrolytic plate, also in cans with 1.25 OPM plate bodies and bonderized (chemically-treated blackplate) ends. Packs were to be put up in cans of 1.25 OPM plate (bodies and ends) as controls.* Experimental cans were inside enameled but, wherever possible, duplicate packs were prepared in cans plain inside (not enameled). All commercially canned fishery products now packed in the United States were included; and packs have been made at Eastport, Jonesport, and Portland, Maine; Gloucester, Mass.; College Park, Md.; New Orleans, Houma and Golden Meadow, La.; Monterey and San Pedro, Calif.; and Astoria, Oregon. A total of 191 packs of 33 different products was prepared under the 1942-43 program.

Packs of Pacific Coast products were made under the direction of the Technological Laboratory of the Fish and Wildlife Service at Seattle, Wash.; and Atlantic and Gulf Coast packs by technologists of the Service's Laboratory at College Park, Md. All packs were prepared in commercial canneries, and standard procedures in handling, packing, processing, cooling, storing, and shipping were followed. Half of each pack prepared on the Pacific Coast was sent to the College Park Laboratory. This gave a 3 - 4,000-mile shipping test for products from the Pacific Coast, and about 600 - 1,500 miles for Atlantic Coast products. Results obtained at the two laboratories were checked against each other.

Upon arrival at the laboratories, samples were divided into two portions: one was held in incubator storage at a constant temperature of 90° F.; the other stored at room temperature. Samples were withdrawn from storage at each temperature and examined at approximately 30-day intervals. This examination was coordinated with the methods followed in other canning research laboratories, and was intended to determine the internal condition of the container, by noting the presence or absence of iron sulfide, tin sulfide, spangling, corrosion, etc., according to a standard grading scale. The vacuum, headspace, external appearance, color, flavor, and odor were also noted, especially as affecting or affected by, the condition of the plate or enamel.

In addition to the periodic physical and organoleptic examinations, chemical analyses are currently being made to determine the amount of dissolved tin and iron. Considerable difficulty has been experienced in working out a satisfactory method for the determination of tin, however, so that very few tin analyses have been completed to date. Iron determinations have been completed on most of the products. Since data are lacking on the composition of canned fishery products, it was also thought advisable to make proximate analyses of each product canned. This would make available information on the moisture, protein, fat, and ash (mineral) content, of all fishery products canned commercially. Proximate analyses have been made of all products packed under the 1942-43 program.

Some of the sample lots have now been packed for 10 months, the more recent about 3 months. All products have had at least one physical examination, while some have been examined five or six times. Sample packs should remain in storage one year, unless they become commercial failures previously, before considering the experiment completed. Some packs have already failed, so that conclusions may be drawn in these instances; and there are indications as to the possible results in most other cases.

Sea herring, for one example, cannot be packed in unenameled cans. In 1942, the commercial pack was made in cans of 1.25 OPM plate, plain inside. Experimental packs of sea herring canned in this plate showed severe detinning in 90 days and were commercial failures at 120 days. The two types of electrolytic plate detinned at about the same rate as the 1.25 OPM plate. The cans with 1.25 OPM bodies and bonderized ends showed no action of the product on the ends, but the bodies detinned at the same rate as other types in the sea herring series. There was no apparent difference in the rate of detinning between incubated samples and those held at room temperature. Herring packed in .5 electrolytic plate cans, inside enameled, showed no indications of sulfide staining or detinning. Iron determinations on sea herring in inside enameled cans are very low, in contrast to the packs made in plain cans.

*The containers consisted of 1.25 OPM plate as control (1.25 lbs. tin for base box of standard plate, Office Production Management approved plate. A "standard base box" is a bundle of 112 sheets 14 x 20 inches of plate); 0.5 acid bath melted fused electrolytic plate (plated by electrolysis, which requires only 0.5 tin for base box standard plate. The acid bath refers to acid dip prior to the electrolytic coating process. "Melted fused" is a steel-maker's term for the type of steel plate used as the base); 0.5 alkaline bath melted fused electrolytic plate (alkaline instead of acid bath); and 1.25 OPM plate with Bonderized ends (Bonderized ends means that the steel plate is not tinned but has been given a patented chemical treatment.)

Theoretically, a better tin coating should be obtained with an alkaline bath electrolytic plate, than with an acid bath electrolytic plate. Our alkaline bath plate was obtained from two different manufacturers, and all the important canned fishery products were packed in this plate, so far as possible. Considerable difficulties were experienced with the alkaline bath plate: first, in enameling the plate; and, second, in making up the enameled plate into cans. Faults developed in the enamel coat in both operations. All attempts to make up 1-pound oval, and ½-drawn cans of this plate were failures. Experimental packs, which were made up of alkaline bath electrolytic plate, showed much more aloughing or peeling of the enamel than other types of inside enameled cans in this series.

The bonderized (chemically-treated and enamled blackplate) ends seem generally satisfactory, with no sulfide staining, discoloration, peeling or blistering of the enamel in most cases. There are exceptions to this rule, however. For example, both California and Atlantic, or "Boston", mackerel shows moderate peeling of enamel in one series of bonderized ends. Both series of cans with bonderized ends show light peeling in the packs of river herring (alewife). The packs of yellowfin and striped tuna show moderate peeling of bonderized ends in one series of tuna cans with 1.25 OPM bodies, plain inside; but there is no peeling of enamel on the ends to date in the same series where the cans are inside enameled. There is also slight peeling of the bonderized ends in one series of Pacific oysters.

All packs in .5 acid bath electrolytic plate, inside enameled, seem generally satisfactory to date. Some iron sulfide staining of the enamel appeared after about 30 days' storage, in packs of "deep sea" fish roe, fish flakes, Boston mackerel, California mackerel and wet pack shrimp. The discoloration could not have been graded worse than moderate in any case; is confined to staining or etching of the enamel, and does not seem to intensify with a longer period of storage. There is no discoloration at all of the product itself. There is light peeling of enamel under a "rub" test, in a few products; but this is very irregular, sometimes occurring only with a single sample can, and not in other cans at subsequent examinations. It would seem that this plate could be used for all canned fishery products.

In storage and shipping tests, it was noted that the external surface of .5 acid bath electrolytic cans showed corrosion and other defects much more rapidly and to a greater extent than cans of 1.25 OPM plate held under the same conditions. Possibly the .5 electrolytic plate should be enameled on both sides, or the cans should be lacquered after packing, to obtain the best results.

Little difference is noted to date between control packs in 1.25 OPM plate, inside enameled, and the packs in .5 acid bath electrolytic plate, inside enameled. This is also true of the division of samples between incubator and room-temperature storage. As room-temperature storage is in an attic, however, at a temperature of about 90° F. or higher in summer months, this is not considered significant.

It is expected that studies on the 1942-43 packs will be concluded early in 1944, and that a final report will be available shortly thereafter. Additional series are planned for the 1943-44 season. These will include experimental cans it was not possible to test in the current series; and the outline of procedure will, of course, be modified as a result of information obtained so far.

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THE SUITABILITY OF NON-TIN CONTAINERS FOR SHIPPING FRESH SEAFOODS

By J. M. Lemon and S. R. Pottinger*

To find suitable non-metallic containers for shipping several varieties of fresh seafood, the U. S. Fish and Wildlife Service has tested a large number of containers of various brands and designs under laboratory conditions. Although the investigation has dealt largely with non-metallic containers, those requiring some metal in their construction have been included.

Those which have shown promise of withstanding exposure to water and ice without excessive deterioration or softening are then examined under actual shipping conditions. The containers are filled with a suitable seafood, packed in crushed ice in a shipping container,

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and shipped to distant points, where they are then examined. Those containers which are now in use to some extent commercially are examined in large numbers at seafood stores after shipment from the packing houses.

Fresh-shucked Oysters--Several brands and types of containers for fresh-shucked oysters have been used in shipping tests. Among the first tested was a heavily-waxed all-fibre spiral container used for a number of years in the food industry. Shipping tests were made with these containers from an oyster shucking house in Rhode Island to the Fisheries Technological Laboratory in College Park, Maryland, where they were examined and then reshipped to Rhode Island for further examination. These containers were found to hold up reasonably well in this test. Another shipment was made from Norfolk, Virginia, to an Army base in Louisville, Kentucky, and was reported to be received in an excellent condition. At about the time these tests were being made, however, the production of this brand of waxed containers was abruptly stopped and has not been resumed.

Another brand of waxed all-fibre container was tested in a shipment from Norfolk, Virginia, to an Army base in Illinois. Although the shipment arrived intact at its destination, the containers were reported to be quite soft. This brand has been improved recently by increasing the number of plies used in its construction, resulting in a more rigid container. Due to the closing of the oyster season, however, no shipping tests were made with this new container.

Shipping tests conducted on a third brand of waxed all-fibre container were only partly successful, due to extreme softening and structural failure of the container. Furthermore, the output of its manufacturer is quite limited and no new orders are now being accepted.

Restrictions on the use of metal cans were eased last winter and spring to permit the use of chemically-treated blackplate in the manufacture of the one-gallon size friction top can for shipping oysters. Several companies submitted cans made of this material to the College Park Laboratory for test purposes. A shipment consisting of a barrel containing 19 of these cans filled with shucked oysters was made from Baltimore, Maryland, to Louisville, Kentucky. It was examined at the destination and reshipped to College Park, Maryland, for further tests. The chemically-treated cans were found to be equally as satisfactory as a tinplated can which was included in the shipment for control purposes. Upon being stored in crushed ice at the laboratory for over two weeks, slight rusting occurred on the outside of several chemically-treated cans. This failure of the coating was brought to the attention of the manufacturers, and improvements have since been made. The cans were found, in general, to be quite satisfactory for shipping shucked oysters.

A combination fibre and metal can has proven fairly satisfactory in other industries for shipping certain types of liquid products. The metal ends impart strength and rigidity to the cans, and a large saving in metal is made by the use of the fibre body. Several sample cans of this type, made especially for oysters, were used in a shipping test from Seattle, Washington, to College Park, Maryland. Upon arrival at the laboratory, the outside surface of the fibreboard was found to be slightly scuffed, exposing a black surface underneath; the interior of the cans remained in perfect condition. After further storage in ice in the laboratory for 11 days, very little change occurred in the condition of the cans, and softening of the fibre bodies was negligible.

Fresh-cooked Crab meat--Because of the comparative "dryness" of fresh-cooked crab meat, a suitable fibre container for this product is less difficult to produce than is a container for a product which is packed with free liquid, such as shucked oysters. Such a container should have a cover that is tight fitting and which will prevent water from leaking into the top of the can. A brand of heavily-waxed, all-fibre crab meat container now on the market has proven to be quite satisfactory structurally for shipping East and Gulf Coast crab meat. A shipping test was made with these containers from Biloxi, Mississippi, to the Technological Laboratory at College Park, Maryland. They were found to be in excellent condition upon arrival at their destination. Although this was the only shipping test made with fibre crab meat cans by this laboratory, over three dozen commercially-shipped barrels of these containers have been examined at various seafood houses in several large cities. The containers were found to be in good condition in practically all instances.

Fresh-cooked Shrimp--Fresh-cooked shrimp is also a fairly "dry" product and does not present any serious difficulties insofar as packaging is concerned. The package, however,

should be watertight to the extent of preventing the entrance of water from the melting ice in which it is packed and should be provided with a cover which will remain in place under conditions of rough handling. The recently improved gallon-size heavily-waxed fibre spiral type of container has been used extensively for shipping fresh-cooked shrimp and has proven to be comparatively satisfactory for this purpose. Although the Service has conducted no shipping tests with this container, a large number which were used in commercial shipments from the packing houses to seafood dealers have been examined. They were found to arrive at their destinations in a satisfactory condition.

Fresh Fish Fillets--Probably the largest current user of fibre containers for unfrozen fishery products is the fresh fish fillet industry. A heavily-waxed fibreboard fillet box, of the telescopic type, has been developed which retains its strength to a fair degree when packed in crushed ice, and which is sufficiently watertight to prevent the entrance of water from the melting ice. A number of these boxes, used in commercial shipments, have been examined and were found in most cases to be satisfactory. In a few instances, the boxes had been crushed to a slight extent, but it is thought that this was caused largely by excessive weight due to the placing of too many boxes in a single large shipping container and subsequent rough handling in transit. Improvements in the fibreboard used in these boxes are constantly being made, and it is quite possible that present weaknesses in fibre fillet boxes will be largely overcome.

Discussion--Fibre containers are susceptible to various degrees of softening when exposed to water and ice. In the newer and improved types, particularly in the smaller size containers, this softening has been greatly reduced and has, in general, become a minor factor in making satisfactory seafood shipments. The larger size containers, because of the greater total exposed surface, present a more serious shipping problem and unless packed properly, may be damaged or crushed in transit. For this reason, a smaller number of large size fibre containers should be packed in a single shipping container, so as to prevent crushing due to excessive weight.

Although a container may be satisfactory insofar as structural characteristics are concerned, other factors equally as important must be taken into consideration before it can take its place as a suitable replacement for the tin container. The most important factor to be considered at the present time is its availability, particularly if a fibre container. Not only is the existing equipment for manufacturing these containers running at capacity, with orders booked months in advance, but a shortage of the fibreboard itself is hindering large scale production.

The so-called watertight or spiral type of all-fibre container, to be acceptable for shipping fresh-shucked oysters, must meet certain Government requirements, such as the printing of certain pertinent information on the cans and the use of tamper-proof consumer packages in some states. It is difficult, if not impossible, at this time to obtain side-wall printing on heavily-waxed fibre cans. Cans made entirely of fibre are not readily made tamper-proof. Hence, these considerations introduce further difficulties.

The combination fibre-metal containers appear to be the best solution to the problem of obtaining satisfactory watertight and tamper-proof cans, and at the same time using a minimum of metal. The difficulty in obtaining sufficient supplies of fibreboard and wax, and the limited manufacturing facilities of companies equipped for producing these cans is again to be considered, however. In the replacement of tin containers, the shortage of fibreboard is rapidly becoming a problem equally as important as the shortage of metal itself.

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EFFECT OF PACKAGING METHODS ON SPOILAGE OF CRAB MEAT

By Charles F. Shockey, Maurice E. Stansby, and R. Paul Elliot*

The shipping of fresh dungeness crab meat for any great distance or the holding of fresh crab meat for any great length of time has always presented the industry with problems even when the tin supply was ample. These problems were even greater than those encountered with other fresh fishery products due to the readily perishable nature of fresh crab meat.

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With the advent of substitute containers, the problems have increased considerably. Several theories regarding the cause of the rapid decrease in the quality of fresh crab meat when packaged in substitute containers have been given; namely, (1) that the paperboard container acted as an insulation which delayed the cooling of the product to proper refrigeration temperature thus allowing excessive initial bacterial action; (2) that certain of the paperboard containers themselves imparted off odors to the product; and (3) that the more rapid spoilage of fresh crab meat packaged in paperboard containers was largely due to entrance of air through the container which accelerated either bacterial or chemical reactions or both.

It was with the above-mentioned facts and theories in mind that an effort was made to establish the cause for accelerated spoilage of fresh crab meat in substitute containers and as an ultimate goal, it was hoped to be able to overcome the problems peculiar to the storage and shipment of fresh crab meat in substitute containers so that a satisfactory means of handling it without the use of tin-plate could be recommended to the industry.

Methods of Study--In these experiments, the crab meat was obtained directly from the picking tables from a crab-shipping plant on the coast. Four samples of each lot were taken at random for the purpose of making bacterial counts and for total volatile base determinations. The remainder of the crab meat was then packed in sextuplet in various types of containers all of which were of one-half pint size and of comparable shape and dimensions.1/ With the exception of the first series, body meat only was used. The results from this series clearly indicated that the body meat spoiled much more readily than the leg meat; therefore, packing tests need only be limited to body meat. These containers, immediately after packaging, were iced in the regular commercial style with the exception that considerably more ice was used in order to provide more uniform refrigeration.

In each case, a number of containers, in addition to those of the test series, were included for the purpose of being opened periodically to determine the best time for the examination of the entire lot. In this way, the test containers were not handled and all would receive uniform treatment.

At the end of the storage period, the contents of the various containers were emptied into numbered sterile beakers (not in any special sequence) and examined for odor by eight to eleven of the staff members. Samples were then taken for bacteriological and chemical analysis.

Spoilage of Crab in Containers Made of Different Materials--Three types of waxed paperboard containers (two heavily-waxed and one lightly-waxed) were compared with tin. The data in Table I show that spoilage was least in tin and in the two heavily-waxed types,

Table 1--Data on a Seven Day Storage Test of Crab Meat in Containers Made From Different Materials

Type	Organoleptic Observations Average of Five Observers	Bacterial Count Per Gram Flesh	
		Initial	After Storage
		Millions	Millions
Tin	1 Sl. Stale 5 Sl. Sweet 1 Sweet		
Average	-	0.85	39.6
Heavily-waxed No. 1 paperboard	1 Sl. Stale 1 Sl. Flat 4 Sl. Sweet		
Average	-	0.85	30.7
Lightly-waxed paperboard	1 Sl. Putrid 4 Stale 1 Sl. Stale		
Average	-	0.85	245.5
Heavily-waxed No. 2 paperboard (another lot of crab stored 8 days)	2 Stale 2 Flat 2 Sweet		
Average	-	2.01	181.8

and much greater in the lightly-waxed type. The heavily-waxed containers had about 25 times as much wax per unit of area as the lightly-waxed type. The latter containers when stored with water inside lost 5 percent weight in two days whereas the heavily-waxed type lost

1/ Dungeness crab meat is packaged in 1-pound and 5-pound containers in commercial practice, therefore, the laboratory tests reported do not represent strictly commercial conditions.

no appreciable amount. The permeability to oxygen of the lightly-waxed type was from 2.6 to 2.9 times greater than that of the two heavily-waxed types. These tests suggest that differences in spoilage rate of crab meat packed in different types of containers may be due to permeability to gases of the different containers.

Effect of Liners on Spoilage of Crab Meat in Substitute Containers--If crab meat is contaminated by absorption of odors from the waxed containers, it would appear reasonable that paper liners should reduce such contamination. In one series, the crab meat was stored in the lightly-waxed containers and in the same containers lined with parchment paper. As shown in Table 2, the parchment paper afforded no protection. In another series, moisture

Table 2--Data on a Seven Day Storage Test of Crab Meat in a Lightly-waxed Paperboard Container Lined with Parchment

Type	Organoleptic Observations Average of Five Observers	Bacterial Count Per Gram Flesh	
		Initial	After Storage
		Millions	Millions
Lightly-waxed paperboard (unlined)	1 Sl. Putrid 4 Stale 1 Sl. Stale		
Average	-	0.85	245.5
Lightly-waxed paperboard (parchment lined)	2 Putrid 2 Sl. Putrid 1 V. Putrid 1 Sl. Stale		
Average	-	0.85	307.5

vapor proof Pliofilm was substituted for the parchment paper. In this case (Table 3) the use of the Pliofilm greatly retarded spoilage which was no greater than that of crab stored in sealed tin. These results suggested that the poorer results with the lightly-waxed con-

Table 3--Data on a Seven Day Storage Test of Crab Meat in a Lightly-waxed Paperboard Container Lined with Pliofilm

Type	Organoleptic Observations Av. of 5 Observers	Bacterial Count Per Gram Flesh		Total Volatile Base Per 100 Grams Flesh	
		Initial	After Storage	Initial	After Storage
		Millions	Millions	Mg. N	Mg. N
Tin	1 Sl. Stale 2 Sl. Sweet 1 Sweet 1 V. Sweet 1 Normal				
Average	-	0.78	3.3	5.14*	17.12
Lightly-waxed paperboard (unlined)	6 Putrid				
Average	-	0.78	8.6	5.14*	64.21
Lightly-waxed paperboard (pliofilm lined)	1 Sl. Stale 2 Sl. Sweet 2 Sweet 1 Normal				
Average	-	0.78	2.3	5.14*	14.15

*Total volatile base was not determined on these samples when fresh, but for the sake of comparison, the N value for a later sample taken under similar conditions was determined as 5.14 Mg. N per 100 Gram of crab meat.

tainers was due to entrance of something from the outside. In several instances where considerable moisture had entered the containers through defective seams (in a few cases completely covering the crab meat) no evidence of greater spoilage was present thus indicating that moisture was not the controlling factor.

Effect of Access to Air on Spoilage of Crab Meat--In one series, the crab meat was stored in tin with lids fastened loosely and in tin with hermetically-sealed lids. The containers with loose lids permitted air or water vapor to enter but not water. As shown in Table 4, spoilage was much greater in the containers with the loosely-fastened lids.

In another series, the crab meat was stored in heavily-waxed paperboard containers and in tin cans with and without the usual holes in the bottom. The crab meat spoiled more rapidly in the containers with holes; and the rate was somewhat greater in the paperboard type (Table 5).

Table 4--Data on a Seven Day Storage Test of Crab Meat in Hermetically-sealed and Loosely-sealed Tin Cans

Type	Organoleptic Observations Average of Five Observers	Bacterial Count Per Gram Flesh	
		Initial	After Storage
		Millions	Millions
Tin (hermetically-sealed)	1 Sl. Stale 4 Sl. Sweet 1 Sweet		
Average	-	0.85	39.6
Tin (loose lids)	3 Stale 3 Sl. Stale		
Average	-	0.85	178.0

In another series, the crab meat was packed in three lots of lightly-waxed paperboard containers, one of which was packed directly in ice, a second in ice in a glass desiccator

Table 5--Data on a Eight Day Storage Test of Crab Meat Stored in Containers Having Holes in Bottom

Type	Organoleptic Observations Av. of 9 Observers	Bacterial Count Per Gram Flesh		Total Volatile Base Per 100 Grams Flesh	
		Initial	After Storage	Initial	After Storage
		Millions	Millions	Mg. N	Mg. N
Tin	1 Sl. Stale 3 Sl. Flat 2 Sl. Sweet				
Average	-	4.6	2.75	5.08	20.0
Tin (holes)	2 Sl. Putrid 1 V. Stale 3 Sl. Stale				
Average	-	4.6	8.9	5.08	27.1
Heavily-waxed No. 1 paperboard	1 Stale 3 Sl. Stale 1 Flat 1 Sl. Flat				
Average	-	4.6	3.4	5.08	16.1
Heavily-waxed No. 1 paperboard (holes)	1 Sl. Putrid 2 Stale 2 Flat 1 Sl. Flat				
Average	-	4.6	14.5	5.08	32.9

which excluded much of the air, and the third lot in ice in a glass desiccator from which the air was evacuated continuously throughout the storage period. As shown in Table 6,

Table 6--Data on a Eight Day Storage Test of Crab Meat Stored in Access or Absence to Air

Type	Organoleptic Observations Av. of 10 Observers	Bacterial Count Per Gram Flesh		Total Volatile Base Per 100 Grams Flesh	
		Initial	After Storage	Initial	After Storage
		Millions	Millions	Mg. N	Mg. N
Lightly-waxed paperboard	5 Putrid 1 Sl. Putrid				
Average	-	2.01	536.0	6.0	127.35
Lightly-waxed paperboard (open desiccator)	1 Stale 1 Sl. Stale 1 Sl. Sweet 1 Sweet				
Average	-	2.01	176.5	6.0	17.80
Lightly-waxed paperboard (vacuum)	1 Sl. Stale 1 Sl. Sweet 2 Sweet				
Average	-	2.01	27.3	6.0	8.87
Lightly-waxed paperboard (regular, iced in open box) (4 days)	2 Flat 1 Sl. Sweet 3 Sweet				
Average	-	2.01	33.7	6.0	9.17

spoilage in the absence of air required eight days as compared to four days in ice in the presence of much air, while that stored with a limited amount of air had intermediate keeping quality.

These results clearly demonstrate the desirability of keeping air from dungeness crab meat to enhance keeping quality, and indicate that the chief problem in using substitute con-

tainers is to select a type which is airtight. In none of the experiments was there any indication of absorption of foreign odors from containers. The fact that rapid spoilage was observed in unsealed tin cans as in the substitute containers is rather conclusive evidence that the difference in spoilage was not due to absorption of foreign odors from the paperboard. All evidence indicates that differences in the spoilage of crab meat in the various types of containers is due to the presence or absence of air.

Effect of Precooling on Spoilage of Crab Meat--Studies on precooling were conducted to determine the relative length of time required to cool the crab meat from room to ice temperature using tin and paperboard containers. No significant difference was found for containers varying in size from one-half pint to one gallon.

In another test, crab meat was obtained as previously outlined but instead of packaging all of it immediately after picking, only half of it was packaged and iced. The other half was cooled down as rapidly as possible to 33° F., packaged, and iced. The three types of containers were used in this experiment.

The results obtained (see Table 7) indicate that spoilage is at a minimum when crab meat is precooled before packaging. This applies not only to substitute containers but also to tin cans.

Table 7--Data on a Eight Day Storage Test on Precooled Crab Meat

Type	Organoleptic Observations Average of Six Observers	Bacterial Count Per Gram Flesh	
		Initial	After Storage
		Millions	Millions
Heavily-waxed No. 1 paperboard	1 Sl. Putrid 1 Sl. Stale 1 Flat 3 Sl. Flat		
Average	-	4.1	78.7
Heavily-waxed No. 1 paperboard (precooled)	1 Stale 2 Sl. Stale 3 Sl. Flat		
Average	-	4.1	24.3
Tin	1 Sl. Flat 2 Sl. Sweet 3 Normal		
Average	-	4.1	17.3
Tin (precooled)	3 Sl. Flat 3 Normal		
Average	-	4.1	8.1
Lightly-waxed paperboard	2 Putrid 2 Sl. Putrid 1 Stale 1 Sl. Stale		
Average	-	4.1	67.1
Lightly-waxed paperboard (precooled)	2 Sl. Putrid 3 Flat 1 Sl. Sweet		
Average	-	4.1	14.8

Course of Spoilage of Crab Meat in Substitute Containers--Most tests were made by storing the crab meat in ice until spoilage was imminent and then making a single examination. In one series, periodic examinations were made about every two days as shown in Table 8.

Conclusions and Recommendations--The evidence indicates that it is very desirable to keep air away from dungeness crab meat during storage or shipment. In cases where tinplate is not available, a heavily-waxed type of paperboard container and one without holes in the bottom should be used. Precooling of fresh crab meat before packaging is recommended in all cases.

Table 8--Data on a Storage Test of Crab Meat Packed in Paper Containers for Varying Periods

Type	Bacterial Count Per Gram of Crab					
	Fresh	1 day	2 days	4 days	6 days	8 days	9 days
Heavily-waxed No. 1 paperboard							
a		1.69	3.44	10.9	2.93	11.4	17.9
b		1.88	3.85	22.1	4.2	276.0	11.2
c	2.01	1.75	3.65	8.25	11.7	174.0	149.0
d		1.75	3.60	16.3	17.0	47.9	16.2
e		1.50	3.19	24.2	14.6	114.0	29.7
(Average count)		1.72	3.55	16.4	10.1	124.6	44.6
Lightly-waxed paperboard							
a		2.45	5.23	22.0	441.5	650.0	630.0
b		1.92	4.32	42.9	211.0	456.0	286.0
c	2.01	2.39	4.34	35.0	88.0	473.0	520.0
d		2.17	2.51	37.8	72.9	410.0	405.0
e		1.88	3.73	10.3	68.5	585.0	114.0
f		1.74	3.75	20.4	83.1	642.0	514.0
(Average count)		2.09	3.98	33.7	161.0	536.0	412.0

	Mg. N Per 100 Grams Crab						
	Fresh	1 day	2 days	4 days	6 days	8 days	9 days
Heavily-waxed No. 1 paperboard							
a	6.0	6.98	6.30	6.85	11.93	38.60	44.03
Lightly-waxed paperboard							
c	6.0	6.64	5.97	9.17	87.57	127.35	177.80

	Organoleptic Observations (Average of 9 to 11 People)					
	1 day	2 days	4 days	6 days	8 days	9 days
Heavily-waxed No. 1 paperboard						
a	Normal	Sl. Sweet	Sweet	Sweet	Stale	Sl. Putrid
b	Normal	Normal	Sweet	Sweet	Sl. Putrid	Sl. Stale
c	Normal	Sl. Sweet	Sl. Sweet	V. Sweet	Stale	V. Stale
d	Normal	Flat	Sweet	Sweet	Sl. Stale	Sl. Stale
e	Normal	Sl. Sweet	Sl. Stale	Sweet	V. Sweet	Sl. Stale
Lightly-waxed paperboard						
a	Flat	Flat	Sl. Sweet	Sl. Putrid	Putrid	Putrid
b	Normal	Flat	Flat	Sl. Putrid	Putrid	Putrid
c	Flat	Sl. Sweet	Sweet	V. Stale	Sl. Putrid	Putrid
d	Flat	Flat	Sweet	V. Stale	Putrid	Putrid
e	Flat	Flat	Flat	Sl. Putrid	Putrid	Putrid
f	Flat	Flat	Sweet	Sl. Putrid	Putrid	Putrid

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STUDIES ON THE ICING OF FRESH-COOKED EAST COAST CRAB MEAT

By S. R. Pottinger*

Because of restrictions placed on the use of metal containers there has been an increase in the use of fibreboard for packaging and shipping fresh seafood. Among the products which have been shipped extensively in such containers is fresh-cooked crab meat. A type of fibre container which was formerly used for shipping crab meat caused considerable difficulty due to softening of the paperboard, and the subsequent failure of the container to retain its shape when packed in ice. This weakness has been largely overcome in a more recently developed fibre crab meat container which is, in general, proving satisfactory insofar as structural characteristics are concerned.

There have been, however, a number of complaints from users of fibre containers to the effect that spoilage of crab meat occurs more rapidly in these containers than in tin crab meat cans, particularly during the period of time in which they are in transit. This difficulty has been almost entirely associated with shipments made in very warm weather and, in the opinion of dealers and packers, will be largely eliminated during the cooler months. Slower handling in transit due to war conditions is undoubtedly a contributing factor, which in turn is closely related to the temperature of the meat and to the adequacy of refrigeration provided for the shipment.

Preliminary laboratory experiments were conducted at the Service's Technological Laboratory at College Park, Maryland, to determine the rate of cooling and the storage temperature of fresh-cooked East Coast crab meat packed in tin and in heavily-waxed fibre crab meat

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cans and held under varying conditions of icing. All packages contained 1-pound of crab meat each. The results obtained in these experiments indicate that the method of icing the containers has a marked effect on the rate of cooling, and the temperature at which the meat is maintained. The method of icing is probably a major factor in determining the storage life of this product.

Experimental--A series of tests were conducted to determine the rate at which warm crab meat cools when it is packed in fibre and in tin containers entirely covered with ample quantities of crushed ice. Temperature changes were followed by means of thermometers inserted through the covers of the cans. The initial temperature of the crab meat was about 85° F. After three hours, the average temperature of the meat in the center of the containers was about 35° F. in the tin cans and 37° F. in the fibre containers. At the end of five hours, each of these values had dropped to approximately 33° F. As was expected, the temperature drop was much more rapid near the walls of the containers. These data show practically no difference in the rate of cooling of crab meat packed in tin and in heavily-waxed fibre cans. It is to be emphasized, however, that these results were obtained with containers which were entirely and continually surrounded with crushed ice.

In another series of tests, fibre and metal cans filled with 1-pound of crab meat each were packed in crushed ice so as to have only one-half of the total surface of each can covered, leaving the other half exposed to room temperature. The initial temperature of the meat was about 85° F. After three hours storage, the temperature of the meat near the wall of the un-iced part of the cans was 51° F. in the tin and 62° F. in the fibre cans, while in a similar position in the iced portion of the cans, the temperatures were 44° F. and 52° F., respectively. These values at the end of six hours had decreased to 46° F. and 51° F., respectively, for the un-iced portions of the tin and fibre cans, and to 38° F. and 42 F., respectively, for the portions of these containers which were covered with ice. These data show that improper icing of the containers will result in a slower rate of cooling of the meat which is packed in fibre containers, particularly during the first three hours of storage. It is to be noted, however, that the temperatures in general are much too high in both types of cans for safe keeping of the meat.

Similar tests were conducted under conditions of icing sometimes encountered in commercial practice. Warm crab meat, at an initial temperature of about 85° F., was packed in tin and in fibre cans and placed in a keg having a capacity of 16 cans. Crushed ice was placed on the top layer of cans and the keg was shaken so as to distribute the ice around the cans as thoroughly as could be expected by this method of packing. At the end of three hours, the average temperature of the meat in the center of the metal cans was about 53° F., and in the fibre containers, 62° F.; after six hours, the temperature had dropped to 41° F. and 47° F., respectively. The room temperature during these tests was about 86° F.

It may be seen that the meat cools much slower in fibre cans than in metal cans when improperly iced. Furthermore, improper icing of warm crab meat packed in a barrel for shipment may result in high temperatures being maintained, in both types of cans, for unduly long periods of time.

Discussion--Crab meat is a highly perishable product and must be properly refrigerated to prevent rapid deterioration. This is true whether the meat is packed in tin or heavily-waxed fibre crab-meat containers. Preliminary laboratory tests have shown that freshly-picked East Coast crab meat packed in both types of containers, placed immediately in crushed ice and kept thoroughly and continually surrounded with ice, remained in a fresh condition equally as long in fibre as in tin cans. Furthermore, no significant differences were found in the rate at which crab meat cools in the two types of containers, provided they were entirely surrounded with crushed ice.

A marked difference was found, however, in the relative rate of cooling of crab meat packed in tin and in fibre when the containers were only partly covered with ice. Under these conditions, temperature ranges within both types of cans were much too high for proper storage of the meat and would be conducive to comparatively rapid spoilage. The slower cooling rate of the meat held in improperly iced fibre containers may thus be an important factor in the decreased keeping quality which has been reported for crab meat packed in these cans.

Although the effect of poor icing may be more pronounced with fibre containers, it is an important factor to be considered in the refrigeration of crab meat in tin containers.

Cans, either fibre or tin, which are packed carelessly so that only part of the total surface of the individual cans is in contact with or covered with ice and which depend largely on the cooling effect of water from the melting ice to refrigerate them, may not be cooled sufficiently in warm weather to prevent rapid spoilage of the contents.

Suggestions for Icing Crab Meat--The following suggestions are made for icing crab meat:

1. Immediately after being filled with crab meat, the cans should be kept thoroughly and continually covered with crushed ice or should be kept at an equivalent temperature.

2. When packing crab meat for shipment, ample quantities of ice should be placed in the bottom of the shipping container, between each layer of cans, and around the individual cans, particularly those near the walls of the shipping container.

3. Sufficient space should remain in the top of the shipping container to allow for an ample quantity of crushed ice over the top layer of cans.

4. This is important: Cans containing warm crab meat should not be packed for shipment, as the warm meat will cause rapid melting of the ice, leaving an insufficient quantity for proper refrigeration in transit. Only thoroughly chilled meat should be packed for shipment.

5. Upon arrival of the shipment at its destination, each can of meat should be kept thoroughly surrounded with crushed ice or should be kept at an equivalent temperature.

6. Cans of fresh crab meat should not be placed on top of a layer of crushed ice for display purposes at warm room-temperatures, as the meat will spoil rapidly under these conditions. Empty cans may be used for this purpose and the filled cans kept nearby in crushed ice.

The use of ample quantities of ice in the shipping and storage of fresh-cooked crab meat will insure a maximum storage life and will result in a fresher, more wholesome product reaching the consumer.

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NOTES ON CANNING GROUND FISH

By Norman D. Jarvis*

The war has greatly increased the demand for canned fishery products. This cannot be filled by increasing the packs of standard products such as salmon, pilchards, tuna, and sardines, because production there is already at maximum levels. Other sources of supply must be developed.

The number of species of fish now utilized in quantity is only a fraction of those suitable for human consumption. Many of these neglected species are found in our shore fisheries and could be taken with boats and equipment now available, or are already taken in fishing for more popular varieties and are discarded as "trash". Most of them, however, are not suitable for canning by methods now used commercially.

In meeting certain of the war demands for canned fish, it is not necessary to have a fancy grade or high-cost product. A relatively low-cost wholesome protein food, permitting efficient use of raw material, container space, packing equipment and labor would be entirely adequate. It is believed that a canned ground fish product meets these various requirements.

The following suggestions have been prepared in conjunction with the War Food Administration to aid packers interested in preparing a product for sale to the Government under the provisions of Form SCP-1524, "Canned Ground Fish - Offer of Sale".

Handling and Transportation--Fish used as raw material for this product must be fresh and in good condition. Lots of fish taken at different times should not be mixed. Fish with high oil content require special treatment. This means extra equipment, higher packing

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costs and closer control over processing, since such fish tend to show "off" flavors in the canned product even after most of the oil is removed, unless processing is very closely controlled. They are also subject to more rapid decomposition than other species.

Proximate Chemical Analysis of Some Common Fishes of the Gulf

Headed, Gutted, and Scaled Fresh Fish

Fish	Percent by Weight			
	Dry Matter	Protein	Fat	Mineral Matter
Croaker	19.5	16	2.0	2.5
Cutlass fish	18	15	1.5	1.5
Menhaden	26	15	9.0	1.2
Mullet	21	15	4.5	1.5
Sea trout	17	15	0.8	1.2
Spot	17	15	0.5	1.5
Southern hake	18	14	2.0	1.5
Southern whiting	20	16.5	1.7	1.8
Star drum	20	16	1.8	2.2
Shark*	20	17	1.0	1.0

*For reference only: Shark is not recommended for canning because of the urea in the flesh. Variations from these averages must be expected in individual lots, depending especially on the size and fatness of the fish.

Some of the raw material must be transported for an appreciable distance. In such instances, the fish should be well-iced. This is also true where the fish must be held at the plant before operations begin. If ice is not available, the fish should be held in a 90° salinometer brine. If the fish remain there over 6 hours, however, the canned product will be too salty in flavor.

Packing--The first operation is washing and scaling. The whole fish should be run through a revolving drum washer of the type used in herring canning, or found in some fresh fish processing plants. A spray of water under heavy pressure, at least 50 pounds, should hit the fish as they go through the drum. Drum washers revolving in a tank of water with little or no circulation of water are not as effective. Heavy metal building lath is suggested for the walls of the drum in place of the usual wire screen. It is believed to have a more abrasive effect on the fish scales.

The next step is cleaning. The fish drop from a conveyor to cleaning tables of the type used in canning river herring. The head is removed by a straight stroke of the knife just back of the gills, pulling outward at the same time the downward cut is made. This pulls out most of the intestinal material attached to the head. It will not be necessary to remove the fins except in case of some of the larger species, when it may be advisable to cut off the tail fin.

Immediately after cleaning, the fish should be washed. Best results are secured when there is a constant flow of water with a paddle, or some other mechanism, to agitate the water in the washing tank. Fresh water of drinking quality must be used in washing.

If the fish cannot be precooked and processed almost immediately after landing, it may be better to clean them at once and hold in brine instead of storing the whole fish in brine. If labor is not immediately available, the fish must be brined whole. While brining is used for purposes of preserving the fish in good condition, the fish are also brined for flavor, to remove blood and slime, and to make the flesh firmer. Fish may be held in a 50° salinometer brine 6 to 12 hours. After this, they are much too salty in flavor.

After brining, the fish must be precooked. Fill the fish in shallow metal pans with perforated bottoms to a depth of not more than 3 inches and cook under pressure for 30 minutes to 1 hour, depending on the size of the fish, at 240° F. to 250° F. Vertical retorts might be used, but would probably require more labor and mean slower operations. A square horizontal cooker such as the "Portland" retort would probably give best results. Steam boxes such as used in oyster canneries for steaming oysters before shucking would also be suitable if a pressure around 10 pounds could be held. Pans could be nested in stacks 4 or 5 deep. Perforated bottoms are needed in the cooking pans so that moisture and condensed steam will run out. This, however, is subject to some experimentation on the part of the plant operator. It may be possible to steam certain species at atmospheric pressure.

The fish must be ground and filled into the cans immediately after cooking and while as hot as possible. Power operated grinders of the "Enterprise" type with a 1/8 to 1/4

inch plate have been found satisfactory in packing pet food. In fairly small operations, the ground material might fall from the grinder into pans which would be carried to packing tables where hand packers would fill the cans, using large ladles to handle the fish. Speed will be absolutely necessary since the temperature at the center of the can must be at least 160° F. when it is closed, if the specified vacuum of 4 inches is to be obtained and the can is to be sufficiently processed. Where there is sufficient material, the fish might fall from the grinder into the hopper of a can-filling machine. A plunger attachment on the closing machine to compress the fish may be needed. Headspace in the can after sealing and processing should not be more than $\frac{1}{4}$ inch.

The cans should be processed as soon as possible after sealing. If this is not done, they do not receive the required cook. The minimum process is 90 minutes at 240° F. for No. 300 cans and 110 minutes for No. 2 cans. No container larger than a No. 2 can should be used unless the retorts are specially equipped with air pressure and water-cooling devices. The pack should be water-cooled 10 minutes after processing then held in the warehouse overnight to complete the cooling before the cans are labeled and cased.

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THE COVER PAGE

Technological research provides basic information necessary in meeting many wartime problems of the fishing industry. This issue of Fishery Market News includes reports of investigations being carried on by the Service's technological staff having relation to some of these problems. Shown in the cover picture are the headquarters of the four Fishery Technological Laboratories of the Service's Division of Fishery Industries: (top) Mayaguez, P. R.; (bottom) Ketchikan, Alaska; (left center) Seattle, Washington; and (right center) College Park, Maryland.

RECENT FISH AND WILDLIFE SERVICE PUBLICATIONS

Fishery Leaflet[1] and Conservation Bulletin[2] series:

Conservation Bulletin 27.--Wartime Fish Cookery. 10 cents
Conservation Bulletin 28.--Home Canning of Fishery Products. 5 cents.
Conservation Bulletin 33.--Fish and Shellfish of New England. 15 cents.
Conservation Bulletin 34.--Fishes of the Middle West. 15 cents.

F.L.#5. Sardines.
F.L.#13. Soft and Hard Clams of the Atlantic Coast of the United States.
F.L.#14. Pacific Salmons.
F.L.#15. Lake Trout.
F.L.#18. Home Preservation of Fishery Products, or Salting, Smoking and Other Methods of Curing Fish at Home.
F.L.#19. Cooking Carp.
F.L.#20. Canning Tuna.
F.L.#21. How to Cook the Burbot.
F.L.#22. Increasing the Production of Oysters and Other Shellfish in the United States.
F.L.#25. List of Publications on Irish Moss.
F.L.#26. Salted River Herring (Alewives) in Chesapeake Bay.
F.L.#29. Crab Scrap as Poultry Feed.
F.L.#30. Preparation of Three Fishes of the Pacific Coast. (Shark, Shad and "Lingcod")
F.L.#33. Whale Meat.
F.L.#36. The Food Value of Fish and Shellfish.
F.L.#37. Canning Atlantic and Gulf Oysters.
F.L.#38. Brine Salted Herring.

"Separates"[3] reprinted from Fishery Market News

Sep. No. 6.--New Weapon Against Oyster-killing Starfish.
Sep. No. 7.--The Canning of Maine Sea Herring.
Sep. No. 9.--Atlantic Sea Mussels as Food.
Sep. No.10.--Seasons, Sources, and Sizes of Gulf Shrimp.
Sep. No.11.--Essential Commercial Fishing Activities Listed by Selective Service.
Sep. No.14.--The Oyster Canning Industry in South Carolina.
Sep. No.15.--The Controlled Materials Plan with Relation to the Fishing Industry.
Sep. No.16.--Preliminary Report on Definitions and Recommended Substitutes for Vessel and Gear Cordage Items.
Sep. No.17.--Wartime Transportation and the Fishing Industry.
Sep. No.18.--Seed Oyster Production in South Carolina.
Sep. No.19.--Loss in Weight and Mortality of Sea Mussels Kept in Storage at Different Temperatures.
Sep. No.20.--Production of Fishery Products in Ala., La., Miss., & Texas During 1942.
Sep. No.23.--The Commercial Importance of Seaweed Gums in the United States.
Sep. No.24.--Brine Salted Mullet.
Sep. No.26.--Compliance with the Federal Food, Drug, and Cosmetic Act in the Marketing of Fishery Products.
Sep. No.27.--Preservation and Care of Fish Nets.

In Preparation:

A Manual for Demonstrating the Cooking of Carp. (To be issued as Fishery Leaflet.)
Principles and Methods in the Canning of Fishery Products. (To be issued as Conservation Bulletin.)

On Smelt.	(For	Fishery	Leaflet	series.)
" Garfish.	"	"	"	"
" Shark.	"	"	"	"
" Mullet.	"	"	"	"
" Rajafish	"	"	"	"
" Monkfish	"	"	"	"

1/ Obtainable upon request from Fish and Wildlife Service, Publications Office, U. S. Dept. of the Interior, Merchandise Mart, Chicago, Illinois.
2/ Obtainable upon request from Supt. of Documents, Gov't. Printing Office, Washington, D. C.
3/ Obtainable upon request from Fish and Wildlife Service, U. S. Dept. of the Interior, Washington, D. C.

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